ELIMINATION OF IMPULSE NOISE INTERFERENCE FROM COMMUNICATIONS RECEIVERS BY THE RF BLANKER METHOD

by

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THESIS

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ABSTRACT

The feasibility of a simple add-on noise blanker for use in the HF range is investigated. Various types of noise blankers are reviewed and the advantages of operating at RF as opposed to IF are established. Performance of gate circuits of varying complexity using PN junction and Hot Carrier diodes is evaluated. To demonstrate the potential of this type of blanker, a simple experimental model is constructed and tested. An improvement in S/N ratio of up to 60 db is obtained for weak signals masked by impulse noise.

TABLE OF CONTENTS

LIST OF FIGURES

I. INTRODUCTION

A. NEED FOR STUDY

RF noise in one form or another is the primary limiting factor in our ability to communicate by radio. Impulse noise is the most commonly encountered, therefore the most troublesome, type of noise. It is characterized by high amplitude, short duration pulses randomly spaced in time and is usually many times the magnitude of the desired signal (1). An efficient means is necessary to eliminate this noise with a minimum degradation of the desired signal.

The amplitude of the pulses is frequently in the millivolt range and may sometimes be as high as several volts. The duration of the pulses, however, seldom exceeds 25 to 50 microseconds (2).

When an impulse arrives at the antenna of a receiver, two effects occur (3). First, the impulse excites the front end tuned circuits of the receiver and produces a bust of RF at the resonant frequency of the tuned circuit. This disturbance will then proceed through the chain of amplifiers of the receiver as if it were a signal. Second, the tuned circuit will continue to oscillate or ring for a period of time after the pulse has ended. The duration of the ringing is inversely proportional to the band width of the tuned circuit. Thus, in a modern communications receiver with high selectivity, an impulse of a fraction

of a microsecond at the antenna will produce a ringing signal that may be several hundred microseconds long at the latter stages of the receivers.

Many systems have been developed to reduce or eliminate this noise; however, they are either ineffective and require constant operator adjustments, or they are large, cumbersome and expensive. A need exists for a simple, low cost system of wide dynamic range that will remove this noise without degrading the desired signal.

1. Limiters vs. Blankers

One principle of devices intended to reduce impulse noise interference is to allow the noise to progress through the receiver and then, at some later stage, to limit the amplitude of the noise to that of the desired signal. This method is called noise limiting, or clipping.

Another approach is to insert a noiseless electronic switch in series with the signal path to render the receiver inoperative during the short duration of each individual noise pulse. This method is referred to as silencing or blanking the receiver.

a. Limiters

The simplest and most practical noise limiters for radio reception employ one or two diodes, either as shunt or series limiters, in either the IF amplifier or the audio system of the receiver. When a noise pulse exceeds a certain predetermined threshold value, the limiter diode acts as either a short or open

circuit, depending on whether it is used in a shunt or series circuit. The threshold is made to occur at a level high enough so that it will not clip modulation peaks enough to impair audio intelligence, but low enough to limit the noise peaks.

Because the limiting action is needed most for reception of weak signals, which are not strong enough to produce AGC action, the threshold setting for weak signals will be incorrect for the reception of strong signals.

The amount of limiting that can be obtained is a function of the amount of distortion of the signal intelligence that can be tolerated. Because excessive distortion will reduce the intelligibility as much as will the noise, the degree of limiting for which the circuit is designed has to be a compromise (4).

The noise limiter operates only when the noise pulse exceeds a predetermined value and causes the diode to conduct. Semiconductor diodes have a breakpoint, or threshold, voltage below which the forward current is very small (about 1 percent of rated value). Beyond this voltage the current increases very rapidly. The breakpoint voltage is approximately 0.2 V for germanium diodes and 0.6 V for silicon diodes.

The large signal level required to operate the diodes makes it necessary that the limiter be located in the latter stages of the receiver, where the signals have already passed through many stages of amplification and many tuned circuits. The noise pulse at

this point have been "stretched" by the ringing action of the tuned circuits and may be several hundred microseconds long. These stretched pulses now are wide enough so that they are present for an appreciable percentage of the total time and further degrade the recovered intelligence. The AGC circuits of receivers respond to the average value of the signal energy present. The stretched pulses, having a high value of average energy, develop AGC which reduces the receiver gain and further decreases the effective signal-to-noise ratio.

Thus it is seen that, although simple in design and operation, the typical noise limiter suffers from a lack of dynamic range and does not actually remove the noise but merely renders it less objectionable.

b. Blankers

The noise blanker senses noise impulses and reduces the gain of the controlled receiver stage to zero for the duration of these noise pulses (5). By reducing the gain smoothly to zero, the noise pulses are prevented from passing through the receiver and the problem of pulse stretching, or ringing, of subsequent amplifiers is avoided. The receiver is now disabled for only a few microseconds by each noise pulse; therefore, far less intelligence is lost for each noise pulse compared to the noise limiter method.

A finite time, in the order of 100 to 300 nanoseconds, is required to recognize that a noise pulse is present, to process

this information, and to produce an elimination signal to render the receiver inoperative. The receiver must be turned off smoothly to prevent noise from being generated by the action of the gate itself.

In order that the noise pulse be eliminated completely, it is necessary that the controlled stage, or gate, be turned off prior to the arrival of the leading edge of the noise pulse. The 100 - 300 nanoseconds necessary to recognize the noise pulse and produce the gate turnoff pulse requires that the signal be delayed by an amount of time greater than these combined times. Figure I is a block diagram of a typical noise blanker system which consists of two channels. One channel is the RF signal path and the other is the impulse or noise channel. In the signal path, the interference and the desired signal pass through an RF amplifier to a delay line and into the gate circuit. The purpose of this channel is to delay the RF signal so that the gate pulses may be generated prior to the arrival of the RF signal at the gate circuit.

The signal and interference are also fed to the noise channel. This channel consists of a broad band amplifier, a noise pulse detector, which responds only to signals which have a fast rise time and exceed a preset threshold, a blanking pulse generator, and a gate driver (which turns the gate off to blank out the delayed noise pulse).

c. Types of Blankers

Pulse stretching, or ringing, as the interference progresses through the receiver necessitates that the pulse be eliminated as early as possible in the receiver to minimize the amount of desired signal losses. Ideally, the interference pulse should be eliminated at the antenna terminals of the receiver before it has passed through any amplifier or tuned circuit. The noise pulse induced in the antenna, although much larger than the desired signal, is much too small to trigger the blanking pulse generator directly. Consequently, it must be amplified to a suitable level.

(1) IF/IF Blanker. One approach to the problem of obtaining noise pulses large enough to be used to trigger the pulse generator is to let the signal and noise progress through the receiver until they have arrived at the output of the first mixer. At this point the noise pulses are at the IF frequency and are large enough to trigger the noise detector. However, because the pulses have progressed through several stages of tuned circuits, they have been "stretched" to a width many times longer than at the antenna. This stretching now causes the desired signal to be masked for a longer period of time. The advantage of simplified circuitry in this method is offset by the disadvantage of the increased percentage of time that the desired signal is obliterated (4). Another disadvantage is that strong local signals present at the output of the mixer may also key the blanker.

(2) RF/IF Blanker. To avoid the problem of strong local signals triggering the blanker, another scheme has been used. In it, the noise channel is fed from a separate small antenna and is, in effect, a TRF receiver. A low VHF frequency where no local stations are in operation is chosen. Propagation here (usually around 40 MHZ) is such that the probability of interference from a strong distant station is small. The blanking gate in this system is located in the IF section of the receiver.

The premise is that the frequency spectrum generated by the fast rise time of impulse noise extends well beyond the HF frequency range and any noise interference seen by the communications receiver will also be seen by the noise channel receiver. This may not be the case with modern high-gain directive HF antennas, where impulse interference generated at a distant source may propagate to the receiver site and completely mask the desired signal in the HF frequency range while not being propagated to the blanker channel in the VHF frequency range. For this reason, this technique, while effective against locally generated impulse noise, is ineffective against remotely generated impulse noise.

(3) RF/RF Blanker. The most effective noise blanker is, therefore, one which operates in the same portion of the RF spectrum as the receiver and blanks the noise pulse before it is stretched by any tuned circuits (2). In this sense, the blanker can

be an "outboard" or external accessory to the receiver and therefore will require no receiver modification.

B. STATEMENT OF PROBLEM

The purpose of this investigation is to establish the feasibility of an effective, low cost RF/RF noise blanker for use with HF communications receivers. It is an external accessory requiring no internal modifications to the receiver and is constructed of inexpensive, readily available components of conventional design. The investigation progresses along three major lines:

1. Gate circuits utilizing 2-, 4-, and 6-diode arrangements are investigated.
2. Idealized performance criterion for each circuit in the block diagram are established.
3. A simple feasibility model is constructed to determine the magnitude of the problems to be solved in developing a blanker to meet the aforementioned requirements.

C. REVIEW OF RELATED WORK

The military does not routinely use noise blankers on their HF communications receivers. Commercial use of blankers in communications equipment presently on the market is limited to one Citizen Band transceiver. One manufacturer offers a blanker for use in its FM mobile transceiver as an optional accessory. These blankers are only available with the highest priced equipment (6).

The amateur radio fraternity has experienced the widest availability of noise blankers in the past fifteen years. These blankers have been offered as accessories, however, and their cost has been approximately 20 percent of the purchase price of the companion receiver.

Examples of commercially available amateur receivers with noise blanker accessories are:

1. Squires-Sanders, Inc., Model SS-1R. This blanker is of the IF/IF type and uses a "bidirectional" N-P-N switching transistor for the gate (1). This receiver is in the $900 price class.

2. Collins Radio Co., Model KWM-2. This equipment uses an RF/IF blanker with the noise receiver operating in the 40 MHZ region. This equipment is in the $1300 price class.

3. R. L. Drake Co., Model TR-4. The blanker in this equipment is an IF/IF type that uses a gate with P-N junction diodes (7). The equipment is in the $750 price class.

Two feasibility studies have been performed under military contract for RF/RF noise blankers:

1. Lightning and Transients Research Institute developed, under ONR sponsorship, a blanker optimized to eliminate precipitation static in aircraft ADF receivers (8). Development was completed in 1956 and the unit does not use present day components or techniques (i. e., it uses hard tubes).

2. Southwest Research Institute manufactured for the Department of the Air Force a blanker called by them a "VHF Time Domain Filter," which was intended for use in the 30 to 300 MHZ frequency range (9). Solid state devices were used extensively. However, the equipment was large, complex, and had a value in excess of $40,000.

No reference in open literature was found relating to work having been done on a simple RF blanker of the RF/RF type.

D. SCOPE AND LIMITATIONS OF STUDY

Gate circuit parameters (drive requirements, isolation in the open mode, insertion loss in the closed mode) primarily establish the operational requirements of the other circuits in the blanker; consequently, this study is limited to an extensive investigation of gate circuits with only a simple, feasible model being constructed of the rest of the blanker circuits.

Because of the lack of controlled noise sources, only impulse noise produced by an automotive ignition system is used in the study. This noise is representative of the most troublesome type.

The gate study was limited to determining the best configuration for a gate circuit. Only passive diode gates were considered.

Band width of the feasibility model was restricted to 2 to 10 MHZ by available components and instrumentation. A simple coaxial cable

delay line was employed, although an equivalent lumped constant line could have been used. No consideration was given to active delay lines in the experimental model.

In developing the requirements for each noise blanker circuit in the block diagram, primary consideration was given to the fact that these requirements would have to be met by current standardized circuit design. The RF amplifier, noise detector, and gate driver circuits were of conventional straightforward design.

II. PERFORMANCE REQUIREMENTS OF NOISE BLANKER CIRCUITS

A. NOISE AMPLIFIER

Although the noise impulses at the antenna may be quite large compared to the desired signal, they are much too small to trigger the noise detector, which requires a minimum input signal of 100 millivolts. Therefore, for the blanker to operate on noise pulses of a few microvolts, the noise amplifier must have a gain of up to 100 db. To prevent swamping the detector on large noise pulses, the amplifier must have a dynamic range of over 80 db. This range may be obtained by using detector-derived AGC or by allowing the noise amplifier to saturate on large signals.

The noise amplifier should be designed using conventional pulse amplifier techniques such as used in radar receivers.

B. NOISE DETECTOR

Initiation of blanking by strong carriers is a serious limitation in that the frequency components of the noise impulse also lie within the band of frequencies that it is desired to receive. One solution is to use an impulse detector in the noise channel to accept impulses only and eliminate all carriers present. Another solution is to detect the composite carrier level present at the blanker and derive a voltage to reduce the sensitivity of the blanker to the point where blanking will not occur on the carrier peaks. The blanker sensitivity is reduced to low level noise; however, if the desired carrier is the carrier involved, the need for blanking has also decreased so no problem is presented. If carriers other than the desired one are present, the effectiveness of the blanker is reduced.

The noise detector must operate whenever the signal out of the noise amplifier exceeds a threshold of approximately 100 millivolts. Once triggered, the output should be independent of the input pulse width and magnitude. A fast recovery, one-shot multivibrator may be used to meet these requirements.

C. GATE

The function of the gate is to interrupt the signal transmission path whenever a noise impulse is present at the input to the receivers. Ideally, the gate should have infinite attenuation during the time it is closed and should have negligible insertion loss when open.

The gate must be capable of being rapidly turned on and off and must not inject any spurious noise of its own into the receiver. The RF signal level at the gate may be as low as a fraction of a microvolt. Therefore, any disturbance produced by the gate must be well below this level. This is a very severe requirement to impose on the gate and places a lower limit on the time required to turn the gate on and off.

The gate consists of signal diodes and associated coupling transformers arranged so that some diodes are placed in series with the signal path and others are placed in shunt with the signal path. When the gate is open, a D.C. bias is applied such that the series diodes are forward biased and have a low impedance, whereas the shunt diodes are reverse biased and have high impedance. A gate pulse from the gate driver forces the shunt diodes into conduction, shorting the RF signal to ground through a low impedance. At the same time, it reverse biases the series diodes, placing a high impedance in series with the RF signal. This effectively prevents any RF signal from passing through the gate.

D. GATE DRIVER

The gate driver acts as a buffer and matches the high impedance of the noise detector to the low impedance of the gate.

Gate transients generated by switching the gate on and off too rapidly may introduce more interference in the output than would

have been present without the blanker. Hence, the blanking pulse to the gate must have shaped response on the leading and trailing edges to bias the gate diodes in and out of conduction smoothly.

Provided that the gate is not allowed to open at any time during the pulse, ripple or ringing of the pulse may be tolerated.

The problem of gate pulse transients is primarily one of circuit techniques and can be solved by applying methods applicable to switching circuits.

E. DELAY LINE

Since it takes a finite time--approximately 100 to 300 nano-seconds--to develop the properly-shaped gate pulse through the noise channel, the desired signal path must be delayed to insure that the gate is closed prior to the arrival of the noise pulse.

RG 58 coaxial cable has a velocity factor of 0.66, which yields a delay of 150 nanoseconds per 100 feet of line. Thus, a 200-foot length of this cable could be used to provide the necessary 300 nanosecond delay. The cable has an attenuation per 100 feet of 0.8 db at 3 MHZ and 3 db at 30 MHZ. Accordingly, the loss will be 1.6 db at 3MHZ and 6 db at 30 MHZ.

Lumped constant artificial transmission lines may be used to provide the delay. These lines are composed of series inductors and shunt capacitors to simulate a transmission line in a compact package. The delay-to-rise time ratio--TD/TR--is a figure of

merit for the netowork and the higher the ratio, the greater number of sections required as is indicated by the approximation $N \approx (TD/TR)^{1.5}$, where N is the number of sections (10). A delay line with a 300 nanosecond delay and useable upper frequency of 30 MHZ will have a delay to rise time ratio of 30. Eighty-five L-C sections are required to realize this ratio.

F. RF AMPLIFIER

Two functions are served by the RF amplifier. First, it overcomes both the 1.6 to 6 db loss of the delay line and the 1 to 2 db insertion loss of the gate circuit. Second, it isolates the noise amplifier from any reflections or noise generated at the gate circuit which might otherwise be transmitted backwards through the bi-directional delay line.

Losses in the delay line are frequency dependent; therefore, the amplifier must have a rising gain vs. frequency characteristic of 3 db per decade to compensate for this. The amplifier must be broad band to cover the range from 2 to 30 MHZ with no tuning required.

Input signals encountered during normal operation may vary from less than one microvolt to over 100 millivolts. These signals must be amplified with a minimum of distortion, and no cross modulation with other signals can be tolerated. This circumstance requires that the amplifier have a gain of 2.6 db to 8 db, depending on frequency, and must operate over a dynamic range in excess of 100 db.

III. DESIGN AND MEASUREMENTS OF GATE CIRCUITS

A. TYPES OF CONFIGURATIONS

Signal gates can be grouped into two basic types, depending upon how they perform the gating operation. One type is the shunt or shorting gate, which interrupts the signal by placing a short across the signal path. The typical shorting gate is illustrated in Figure 2. The operation is as follows:

When E_1 is at some positive voltage ($\approx$ 2V),. diodes D_1 and D_2 are reverse biased and act as high impedance elements. In this state, the RF signal passes from the input to the output port with little attenuation. When E_1 is switched to a negative voltage ($\approx$ -2V), diodes D_1 and D_2 are now forward biased and act as very low impedance elements shunted across the signal path, shorting the RF signal to ground. In this state, very little of the signal passes through the gate.

The other type is the series gate, which interrupts the signal by placing an open circuit in series with the signal path. Figure 3 illustrates a typical series gate which operates thusly:

When E_1 is a positive voltage ($\approx$ 2V), diodes D_1 and D_2 are forward biased and act as low impedance elements in series with the signal path. The signal now passes through the gate with little attenuation. When E_1 is a negative voltage ($\approx$ -2V) diodes D_1 and D_2 are reverse biased and act as high impedance

elements in series with the signal. In this state, the RF signal is prevented from passing through the gate. Attenuation of the series gate in the closed mode is degraded by signal leakage through the diode capacity. Mixing in the series diodes may occur on strong local signals producing intermodulation distortion.

The shunting gate has two advantages relative to a series gate:

1. The shunting principle permits dissipation of the energy of the interference pulse.
2. Intermodulation distortion is not introduced when the shunting gate is not activated, since only the shunt capacity of the diodes is effective--and they act as linear passive elements.

However, since with available components, the shunt elements cannot effectively be switched to zero impedance, several shunt gates are required to produce the gate attenuation available from a single series gate.

Combinations to exploit the advantages of each type of gate is desirable. Figure 4 shows the schematic of a 4-diode combination gate. Operation is similar to that of the individual gates in that when E_1 is a positive voltage, the gate is open; and when E_1 is a negative voltage, the gate is closed. The closed gate attenuation, however, has been improved by:

1. The series diodes have inserted a high impedance in series with the small signal developed across the non-zero impedance of the forward biased shunt diodes.
2. The feed through due to the capacity of the series diodes has been decreased because the magnitude of the signal across them is smaller.

A 6-diode gate, using the combination of a series gate with two shunt gates, is shown in Figure 5. The advantage of this gate over the 4-diode gate is the additional attenuation gained by shunting the second sets of diodes across the output. This configuration has the disadvantage of requiring two driving voltages to switch the gate.

B. CHARACTERISTICS OF DIODES

Diodes may be formed by the junction of p-type and n-type semiconductor materials. They may also be formed by the junction of a semiconductor and a metal. These latter diodes are referred to as hot carrier or Shottky barrier diodes.

Unlike the P-N junction diode, the hot carrier diode action is based on majority carrier conduction and in normal operation exhibits virtually no storage of minority carriers. The reverse recovery time of a very fast P-N junction diode may be as low as 3 nanoseconds, whereas the reverse recovery time of a hot carrier diode is an order of magnitude smaller. This rapid recovery and

the conductance of the hot carrier diode gives it superior performance in RF applications over the P-N junction diode.

C. GATE PERFORMANCE MEASUREMENTS

Circuits representative of the 2-, 4-, and 6-diode gate configuration were constructed to evaluate the relative performance of each type. Input and output coupling transformers were wound on Micrometals type T50-2 toroidal cores. Each transformer was wound with 60 turns of No. 28 enamel-covered copper wire. To maintain symmetry, the windings were wound tri-filar with 20 turns each being used for input and output coupling and the remaining 40 turns were center-tapped and used for connections to the diodes. Each gate was assembled on an etched circuit board in order to maximize symmetry of construction and to minimize the amount of signal leakage around the gate due to circuit stray capacities.

The P-N junction diodes used were silicon planar epitaxial passivated (PEP) type 1N914. The Shottky barrier, or hot carrier, diodes were Hewlett Packard type 5082-2811.

Figure 6 is a block diagram of the test setup used to measure gate parameters. An HF communications receiver was used as a detector to measure the signal at the output of the gate. The RF signal generator was set to the receiver frequency, and its output was adjusted to give a predetermined level on the receiver signal strength meter. The gate, in the open state, was inserted in the

signal path and the amount of signal decrease measured, thus giving gate insertion loss. The gate was then placed in the closed state by applying a DC voltage to simulate the gate driver output. The amount of signal attenuation was measured, giving the gate isolation in the closed mode.

Figure 7 is a tabulation of the measured values of insertion loss and gate isolation for the gates tested. Several important observations may be made:

1. Gate isolation improved proportional to the number diodes used and the complexity of the gate.
2. Isolation of the gates decreased as signal frequency was increased.
3. Frequency dependent decrease in isolation for the 4-diode gate using hot carrier diodes was significantly less than for the same gate using P-N junction diodes.
4. The 6-diode gate gave significantly better performance than the other gates. However, biasing the gate open and closed required critical adjustments of the bias voltages, and the bias points shifted as the diodes changed characteristics due to heat generated by diode conduction current.

An 8 db average isolation improvement obtained by using hot carrier diodes in the 4-diode gate emphasized the superior performance of these diodes. The maintenance of isolation as frequency

was increased is attributable to less signal leakage through the lower hot carrier diode capacity compared to the P-N diodes.

The P-N 6-diode gate has an 11 db better isolation at 14 MHZ than the hot carrier 4-diode gate. However, the difficulty encountered obtaining the proper balance between the two gating voltages precluded consideration of this gate in the simple blanker constructed.

IV. NOISE BLANKER FEASIBILITY MODEL

A feasibility model of an RF/RF noise blanker was built to evaluate the kind of performance that could be expected from a simple system using straightforward design and inexpensive readily available components. Figure 8 is a schematic diagram of the test circuit constructed.

Conventional design RC coupled amplifiers were used in both the RF and noise channels. An emitter follower, Q2, matches the RF amplifier to the low input impedance of the gate and isolates gate switching perturbations from the delay line.

In the quiescent state, the noise detector, Q5, is biased at cut-off, allowing the base of the gate driver, Q6, to be forward biased. Q6 is saturated, placing a positive voltage on the gate which keeps the gate open.

When a noise impulse appears at the base of Q5, it conducts, discharging the 200 pf capacitor through the low emitter-to-collector

resistance, biasing the gate driver out of conduction, thus applying a negative voltage to the gate closing it. The length of time that the gate driver remains cut off--hence the width of the gate pulse--is determined by the RC time constant of the 200 pf capacitor and 110K resister in the collector circuit of Q5. A 220 pf capacitor at the base of the gate driver shapes the leading and trailing edges of the pulse to reduce gate transients.

The delay line used was 120 feet of RG-174 miniature coaxial cable which gave a delay of 180 nanoseconds with a loss of 4 db at 30 MHZ. A block diagram of the test set up used to evaluate the performance of the blanker constructed is shown in Figure 9. Random impulse noise normally encountered in HF receivers does not lend itself to oscilloscope photography. Therefore, an automobile ignition system triggered by a pulse generator was used to simulate impulse noise and facilitate synchronization of the oscilloscope.

Figure 10 is a photograph of the receiver IF amplifier output, showing over 200 microseconds of ringing caused by a noise impulse of less than one microsecond duration. The gate pulse generated by this same noise pulse is shown in Figure 11. Output of the IF amplifier after the noise blanker has eliminated the noise pulse from the receiver input is shown in Figure 12. This represents a measured signal-to-noise ratio improvement of over 60 db in the performance of the receiver in a noisy environment.

V. CONCLUSIONS AND RECOMMENDATIONS

A. SUMMARY OF INVESTIGATION

Superior performance over all other types of HF receiver noise elimination methods has been established for noise blankers operating in the RF range of the receiver.

Ideal performance requirements for each portion of the block diagram of an RF/RF noise blanker have been outlined. Although severe, these specifications can be met by using established circuit design techniques and conventional components.

The gate circuit was identified as the circuit which directly establishes the requirements for the other sections of the blanker and hence was the subject of a design investigation. Gates employing combinations of 2, 4, and 6 diodes were evaluated. Gate isolation improved proportional to the number of diodes employed and the complexity of the gate. Hot carrier diodes with their low capacity, high conductance and nanosecond turnon-turnoff capability outperformed the P-N diodes in all gate circuits. Although the more complex 6-diode gate offered 10 db more isolation than a 4-diode gate, its exacting drive requirements led to a recommended use of the 4-diode gate in all but the most severe noise environment.

To demonstrate the potential of an RF/RF external blanker, a simplified feasibility model using discrete components was constructed and evaluated. The performance was typified by the complete

recovery of a 1 microvolt signal from a noise environment with approximately 1 volt impulse noise peaks.

B. RECOMMENDATIONS FOR FURTHER STUDY

Present commercially available lumped constant delay lines are expensive, bulky, and stress maximum uniformity of phase shift, attenuation and frequency dispersion. These electrical features are less significant for a delay line used in a noise blanker; consequently, investigation of a compact, inexpensive delay line with less stringent electrical parameters is recommended.

Consideration should be given to development of a simplified technique to provide the critical driving voltage requirements of the 6-diode gate in order that the superior isolation of this type gate may be exploited.

Readily available inexpensive integrated circuits may be used to perform the functions of the discrete components used in the feasibility model. The possibility of using integrated circuits for an active delay line should not be overlooked.

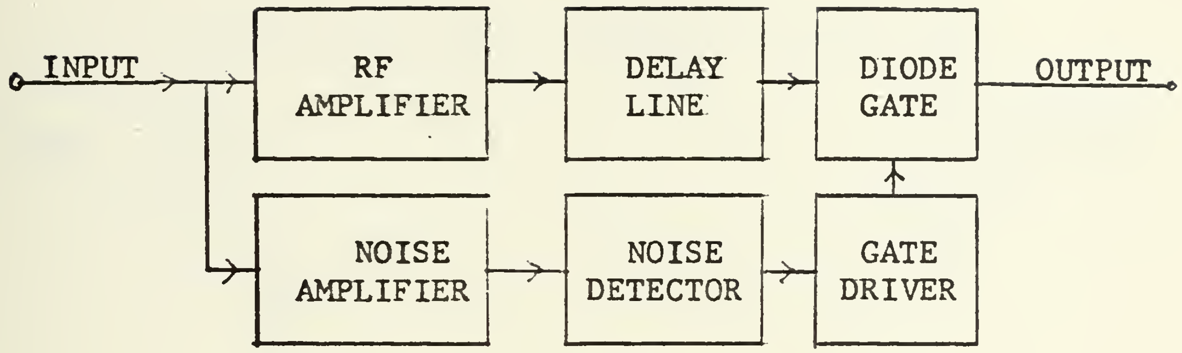

Figure 1.

Block diagram of typical noise blanker system.

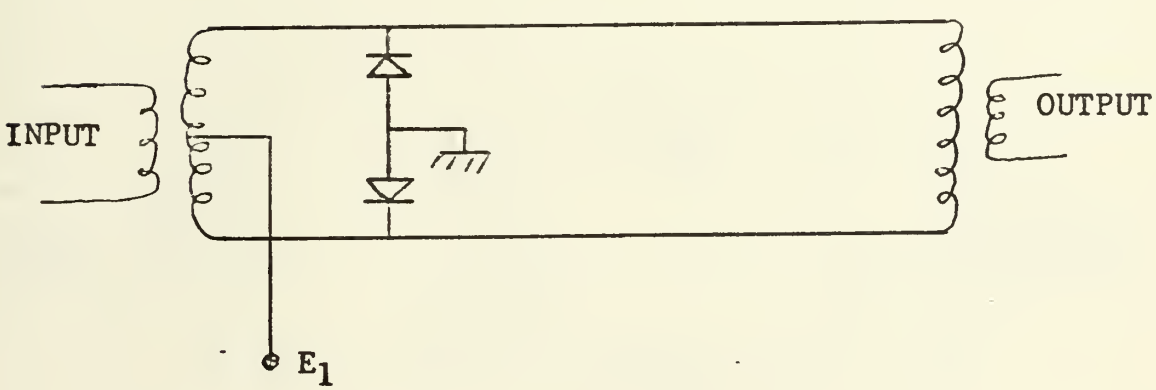

Figure 2.

Typical shunt gate.

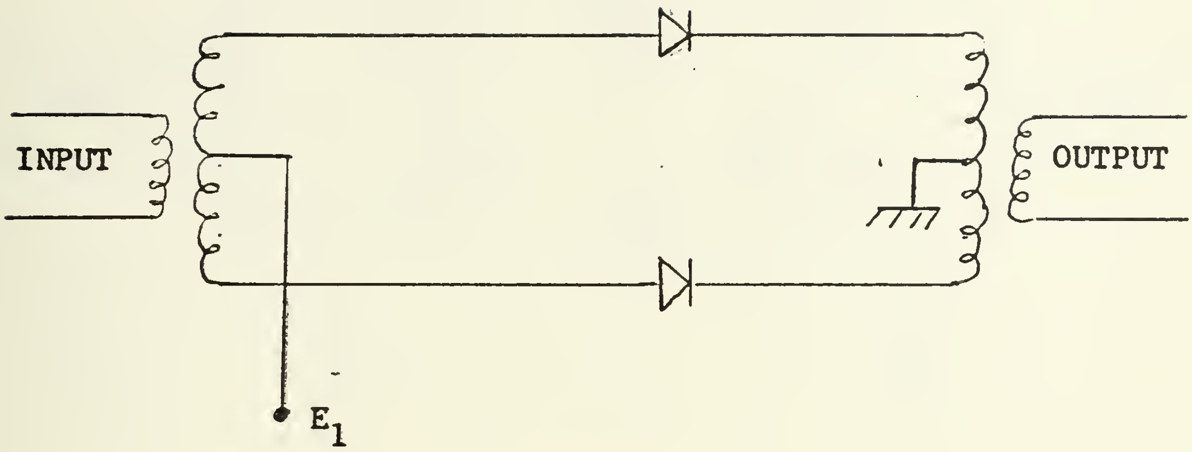

Figure 3.

Typical series gate.

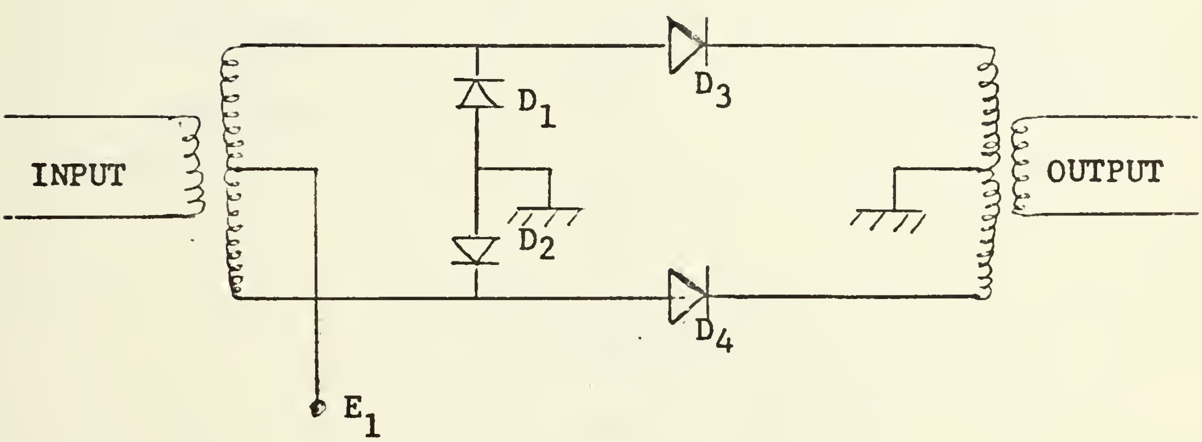

Figure 4.

Four-diode combination gate.

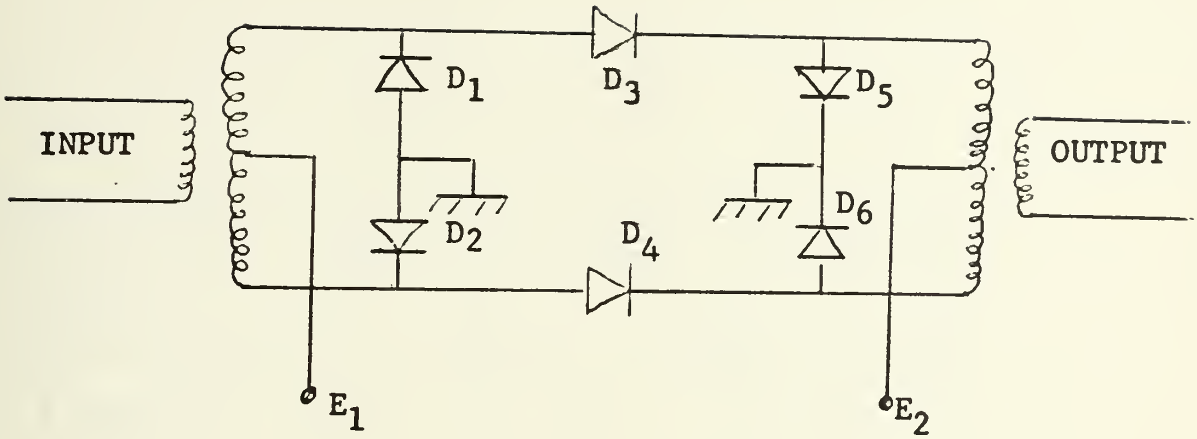

Figure 5.

Six-diode combination gate.

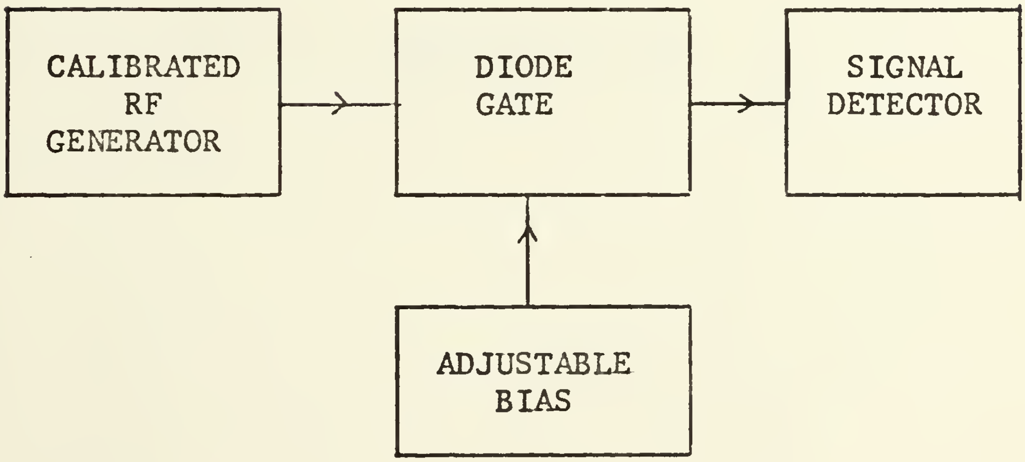

Figure 6.

Gate paramater test setup.

Frequency / Gate Type	14 MHz	21 MHz	28 MHz
2-Diode	--	42	40
4-Diode	64	55	48
6-Diode	75	61	—
4-Diode Hot Carrier	66	63	61

Figure 7.

Measured values of gate isolation in db.

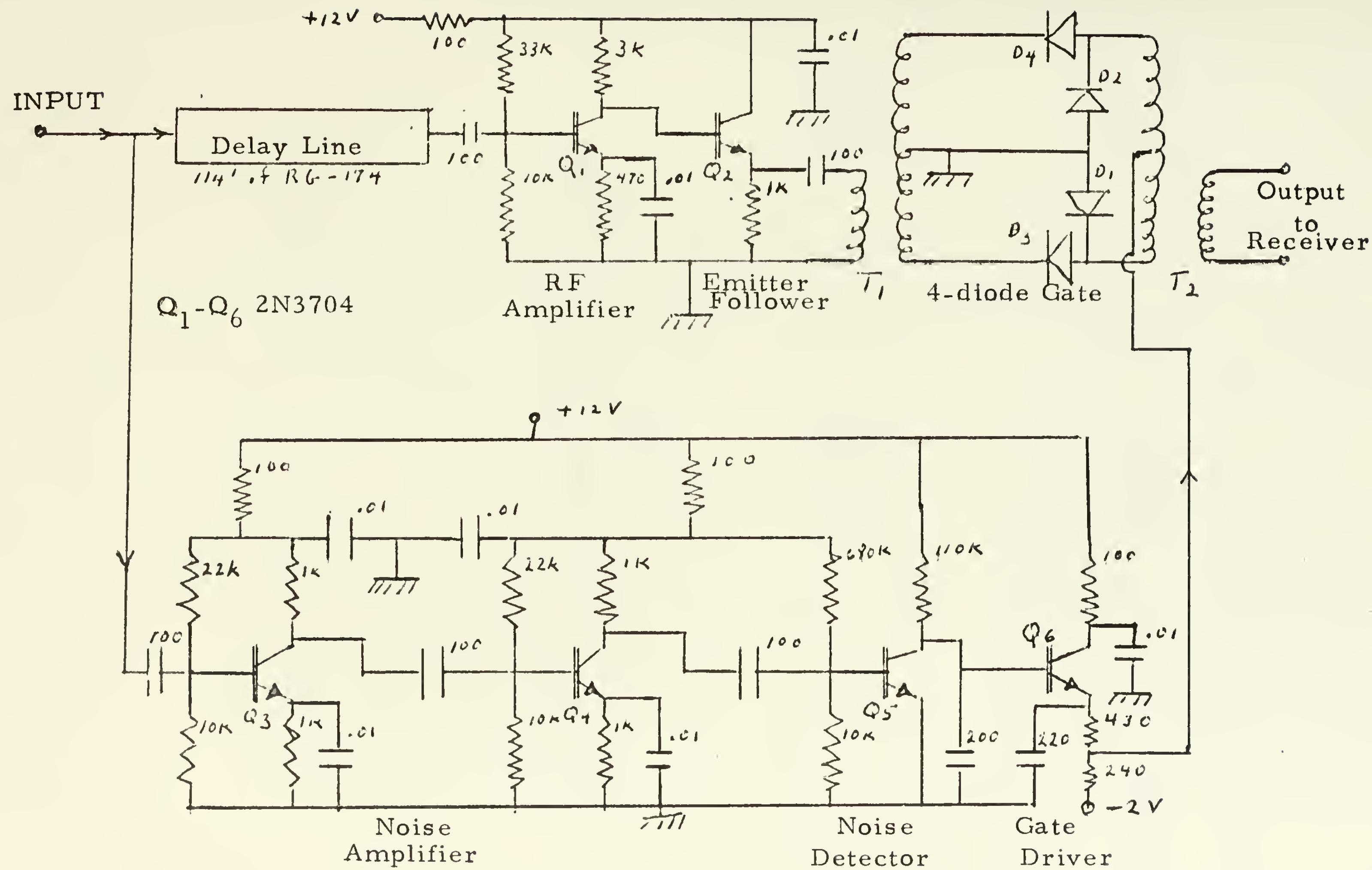

Figure 8.

Schematic diagram of feasibility model.

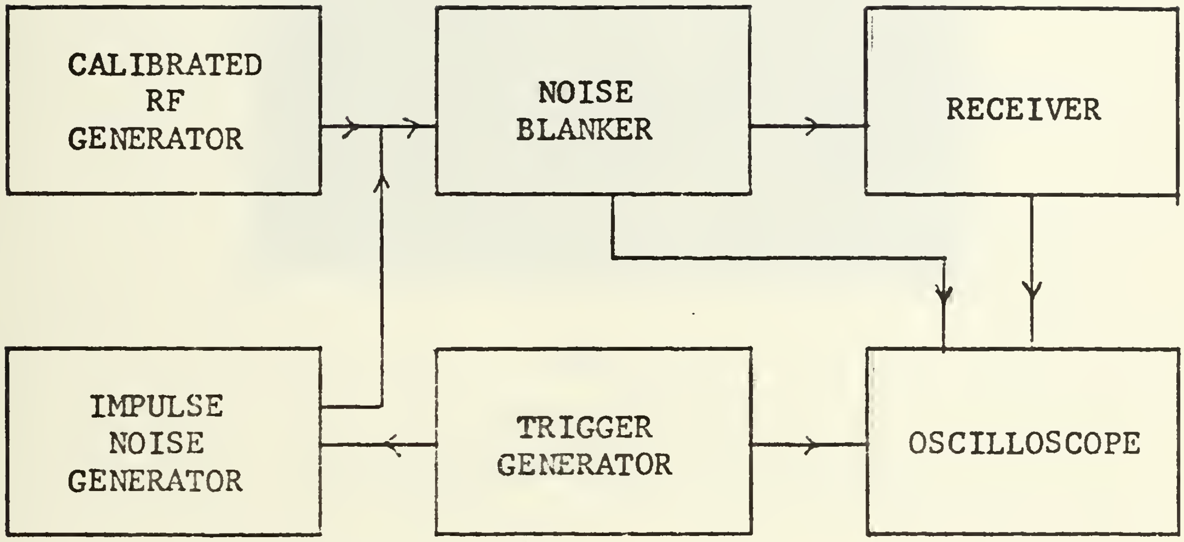

Figure 9.

Feasibility model performance test setup.

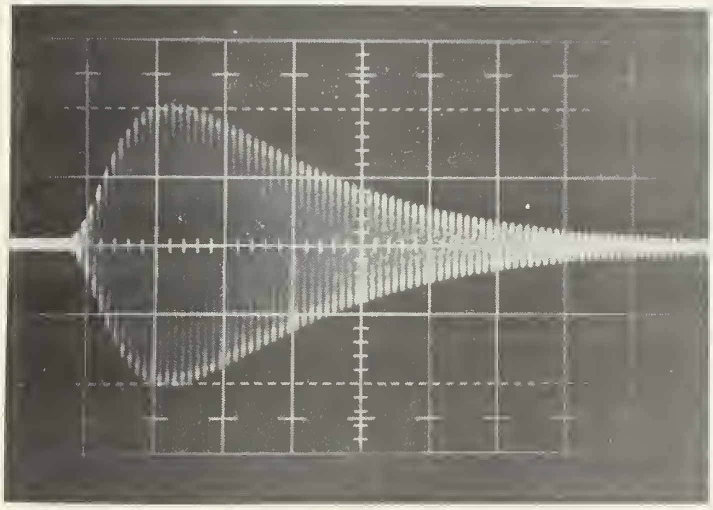

Figure 10.

IF Amplifier ringing.
Horizontal deflection is 20 μs/CM.

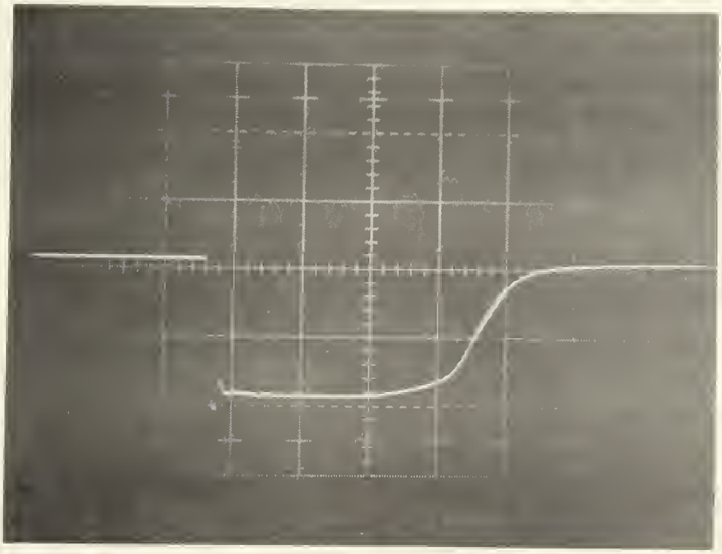

Figure 11.

Gate driver pulse.
Horizontal deflection is 0.5 μs/CM.

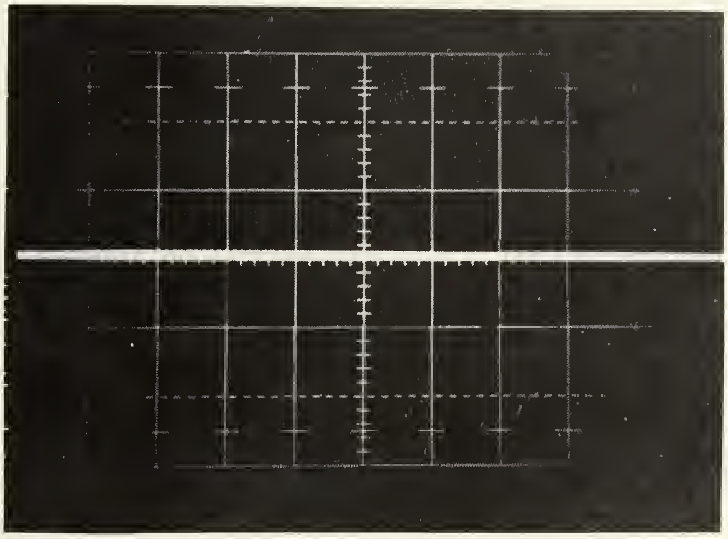

Figure 12.

IF amplifier output with ringing eliminated. Horizontal deflection is 20 μs/CM.

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13. ABSTRACT

The feasibility of a simple add-on noise blanker for use in the HF range is investigated. Various types of noise blankers are reviewed and the advantages of operating at RF as opposed to IF are established. Performance of gate circuits of varying complexity using PN junction and Hot Carrier diodes is evaluated. To demonstrate the potential of this type of blanker, a simple experimental model is constructed and tested. An improvement in S/N ratio of up to 60 db is obtained for weak signals masked by impulse noise.

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
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Impulse noise						
Noise interference						

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